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THE TEACHING OF PHYSIOLOGY[1]

By Professor AUGUST KROGH

UNIVERSITY OF COPENHAGEN

I HAVE been engaged in physiological research and in teaching human physiology for about forty years during a period in which the most astounding progress has been made, and the subject from being of mainly academic interest has developed into being of deep significance for the welfare of mankind.

I wish to contend that the teaching of this branch of natural science has not kept pace with its increasing significance, that it should be taught to a larger number of people and in a more effective way than is usual at present.

I am not now concerned with the teaching of physiology to the small number of students who are going to engage in physiological research; they can pick up their factual knowledge during their apprenticeship, but I am thinking of all those people who need some knowledge of physiology to order their own lives and in their respective trades and professions, and my major contention is that this knowledge should be imparted mainly in a utilitarian way without any attempt to cover the whole subject as academically defined and delimited, but stressing definitely those parts of it which are most useful from the point of view of the pupils and therefore most likely to catch and hold their interest. I am convinced that at all stages the active cooperation of the pupils in the acquisition of this knowledge should be obtained.

Adopting this as my guiding principle, I would like to have the fundamentals of nutrition introduced as a subject in all lower schools—at least in the cities. While it is no doubt true that the instincts of children could guide them to a right selection of natural foods, this does not hold at all in the highly artificial environment in which most children are brought up; and they

[1] An address delivered before the American Academy of Arts and Sciences, Boston, on May 10, 1939.

should learn for their own sake and for that of future generations something about food values and the effects of stimulants in common use.

I would also, on principle, include in the curriculum for all adolescents the elements of sex physiology, but how far this is practicable must depend upon local conditions.

Going to deal now with the teaching of those classes in society which claim to be educated, I wish to record the fact that in Denmark human physiology was introduced in 1908 as a regular subject for all high-school pupils at the age of seventeen to eighteen years. We have nothing to compare with American colleges, and our high schools (called gymnasia) prepare directly for the universities. Allowing for considerable differences in methods and courses, the teaching of these youths corresponds to that in the two first years in college. The pupils, or those responsible for them, have to choose between three lines of education: one stressing classical languages; one, modern languages; and one, mathematics and natural sciences.

Both languages and science are taught, however, to the pupils along all the lines, and a knowledge of human physiology is considered a necessary and essential element of any liberal education.

Pupils, teachers and education authorities are in essential agreement that this subject has proved interesting in itself and of high educational value. I have no doubt that from the point of view of formal education, corresponding values could be obtained from other branches of biological science and that a presentation of the facts of general physiology is even logically preferable, but the natural interest of the pupils centers around their own organism, and here again I would strongly emphasize the utilitarian point of view. A knowledge of the bodily functions and some of their most common disturbances is, on the whole, useful knowledge, and a fairly large number of the pupils will find that this or that bit of it applies directly to their own case.

The physiology taught in our gymnasia is fairly comprehensive, although, of course, elementary. It utilizes the chemistry and physics which the students have at this stage been taught, and it covers the functions of digestion, circulation, respiration, excretion, etc. Nutrition is dealt with at some length, and the functions of endocrines and gonads are included. The nervous and muscular systems are treated in a somewhat summary fashion, but the sense organs, especially the eyes, in more detail. I may perhaps be allowed to refer for further information to an American edition of my own text-book published in 1934 and now therefore largely out of date.

The men and women who teach physiology on this level must themselves possess a sound and a wider knowledge of the subject, and it is essential that during their university training they should have grasped its character as a living and rapidly growing subject so as to be ready to assimilate and utilize the progress made during their subsequent teaching careers and not to be dogmatic on any point. In Denmark we think it important that they should be trained to perform and demonstrate to their pupils simple physiological experiments—mostly on human beings. I have been responsible for the university training of these teachers for thirty years, and although comparative physiology is my favorite field, I have not considered myself justified in introducing more than a few especially striking examples into the curriculum.

Familiarity with certain aspects of physiology is useful or even essential in certain professions. Dentists must know something about nutrition, and engineers ought to know something about the human organism as a motor; but for very large parts of our science, they have no direct application, and there is no reason why they should have more information on these parts than any educated citizen.

The profession in which human physiology is most useful and for which it is now in fact *the* basic science is the medical.

Forty years ago the recognized basis for clinical medicine was morbid anatomy, and the contributions of physiology to medicine as then taught and practised were not numerous, nor were they considered especially important.

The situation now is fundamentally different. Morbid anatomy is still important, of course, but disease is first and foremost a functional disturbance, and how far it can be controlled depends largely upon our understanding of normal and abnormal function. I am happy to state that the conception is gaining ground in this country that the teaching of physiology in medical schools has for its object to educate students to become doctors and not to become dabblers in the experimental and theoretical science of physiology, but tradition is strong, and, as I see it, there is still a great deal that will have to be weeded out from physiological curricula in medical schools and a great deal that will have to be put in. We have to start with the assumption that the students enter medical school because they are interested in medicine, and it is the duty of teachers to make it clear to them at every stage that what is taught has a bearing upon medicine and is going to help them to become good doctors. If this conception is kept in view, it should not be so very difficult to illustrate the teaching of physiology with clinical examples and to stress those phases which have a definite clinical bearing, as, for instance, the central and peripheral disturbances of circulation, the formation and absorption of edema, etc. It is a difficulty, of course, that in the preclinical stage in which physiology is mainly taught the pupils know very little about

medicine, but I am convinced that this difficulty can be largely overcome. The practical courses should not, in my opinion, be arranged to introduce the pupils to the intricacies of physiological experimentation, but, beyond illustrating some basic principles, they should familiarize the students with methods actually useful in medicine. The growth of the science should be emphasized, and it should be taught how to find and use original literature.

I feel very definitely that the practice adopted by a few schools of giving those students who desire it an opportunity to reestablish a close connection between physiology and medicine is very beneficial. It can be done, as I have seen, by establishing courses for older students given jointly by clinical and physiological teachers, but other methods are no doubt available.

I have been much in favor of special chairs for the study and teaching of pathological physiology, and I still think that it may be, in certain circumstances, a useful development, but it would serve as an excuse to make the preclinical teaching too academic, and when a close cooperation can be established between those who teach physiology (normal *and* pathological) and those who teach clinical medicine and surgery, I think the best results can be achieved.

It may be said that the system which I advocate would discourage students from going into physiological research. My reply would be: So much the better. Students should be discouraged from choosing a career involving research, and we should welcome only those whose urge is strong enough to overcome discouragements and difficulties.

THE MODE OF ACTION OF SULPHANILAMID[1]

By Professor PHILIP A. SHAFFER

DISCOVERY of the dramatic therapeutic effect of sulphanilamid in various bacterial infections has stimulated wide-spread interest and renewed activity in the field of chemotherapy for infectious disease. From this renewed activity there should come the discovery of still better drugs for the control of infections. Progress in this new era of chemotherapy is likely to depend a good deal on an understanding of the ways in which the drugs exert their action; without that understanding the search for more useful therapeutic substances is apt to be largely a haphazard venture. It is therefore disappointing to find that in spite of the numerous investigations with sulphanilamid and related compounds there is yet no accepted explanation of their action. In Marshall's recent review of the pharmacology of sulphanilamid,[2] he states: " . . . no satisfactory explanation of the mechanism of action has been found." Yet certain facts have been known for some time which appear to point plainly enough in the direction of a logical explanation. The purpose of this communication is to draw attention to these facts and to cite briefly some new evidence, all of which when combined seem to provide an explanation of the mode of action of sulphanilamid and of related substances.

In June, 1937, R. L. Mayer pointed out[3] that the frequent appearance of methemoglobin in the blood of animals and patients treated with sulphanilamid suggests the formation in the body of an oxidation product of the drug which is responsible for the formation of methemoglobin. He further advanced the hypothesis that the bactericidal effect is due not to sulphanilamid but to the same oxidation product which oxidizes hemoglobin to methemoglobin. In support of this idea Mayer showed that p-hydroxyl amin benzene sulphonamid is highly bactericidal, as the corresponding amine is not. It is the opinion of the present writer that this hypothesis contains the important germ of truth, and if substantiated and developed may supply a rational chemical basis for this important branch of chemotherapy. Should this expectation prove to be correct it will represent the extension of a point of view that prompted Ehrlich in his early experiments with oxidation-reduction dyes and will incorporate also some of Pasteur's ideas on the relationship of fermentation to respiration.

The following facts would seem to be conclusive evidence that sulphanilamid and sulphapyridin are not themselves bactericidal and that their therapeutic (and toxic) effects are due to oxidation products of these substances formed by atmospheric oxygen under the catalytic influence of respiring tissues or organisms.

(1) Both drugs are wholly without effect on the growth of bacteria in the absence of oxygen. Both become more or less bacteriostatic or bactericidal under certain aerobic conditions, but promptly lose this property when the culture media become anaerobic in consequence of bacterial metabolism and the resulting consumption of dissolved oxygen.

The oxidation products of a number of more or less analogous substances, for example, benzoquinone and quinhydrone, are known to be highly bactericidal under anaerobic as well as aerobic conditions, whereas the reduced forms are bactericidal only under aerobic conditions, *i.e.*, when their oxidation is possible.

[1] From the Laboratory of Biological Chemistry, Washington University School of Medicine, Saint Louis.
[2] *Physiological Reviews*, 19: 254, April, 1939.
[3] *Bull. L'Academie de Med.*, 1937, 117: 727, 1937.

(2) When sulphanilamid is given to animals infected by streptococci there is a "lag" of some hours during which little or no inhibition of bacterial growth occurs, after which period the number of bacteria in blood and tissues may rapidly decrease or disappear. This again suggests the inactivity of sulphanilamid as such, but does not prove the active substance to be an oxidation product.

(3) The presence of methemoglobin in the blood of virtually all animals or patients receiving therapeutic doses of sulphanilamid is, as Mayer pointed out, significant. Methemoglobin is the *oxidized* form of hemoglobin, and the appearance of this pigment is probably always indicative of the presence in the blood of an active oxidizing agent not normally there. It is reasonable to suppose that the agent present after giving sulphanilamid is an oxidation product of sulphanilamid.

(4) Active *oxidizing* agents, of sufficient oxidizing intensity, are known to be highly bactericidal for many organisms, provided their oxidizing action is not diverted from the bacteria by being consumed by other reducing substances in the culture fluid. A demonstration by W. M. Clark illustrates this qualification. Many times the lethal concentration of iodine may be added to bacterial cultures without bactericidal effect, if added so slowly as to be at once reduced to iodide ion, thereby avoiding an excess of I_2 and the consequent rise of the oxidation potential of the medium. Similarly, Dubos and others have shown that streptococci and various other organisms do not grow when the oxidation potential of the media is kept above certain levels. The reducing intensities of living cells, produced by the "activation" of metabolites by "dehydrogenase" enzymes, provide one environmental factor essential for growth and in the case of many bacteria essential for life. That essential environment is destroyed and the organisms are killed by such excess of active oxidant as will maintain the oxidation potential above a critical level.

(5) It has recently been reported[4] that sulphanilamid added to broth raises the electrode potential and somewhat delays its fall as growth proceeds. This effect is due to the oxygen (and possibly H_2O_2) contained at the start in the broth since it was not observed under anaerobic conditions or when cystein was added. Sulphanilamid is not an oxidant and is itself inactive toward electrodes. When, however, even a very small fraction is oxidized (as occurs slowly in aqueous solutions exposed to light and air), the product (until reduced or decomposed) imposes a high potential, as will be explained below.

(6) It has been found by Shinn, Main and Mellon[5] that the oxidation product of sulphanilamid produced by radiation (Ottenberg and Fox) destroys catalase and thus allows H_2O_2 to accumulate in respiring bacterial cultures. From this observation they advance the hypothesis that the bactericidal action is due to H_2O_2.

To the above significant observations the writer is able to add the following facts.

Although virtually unaffected by atmospheric oxygen in the absence of catalysts, sulphanilamid and sulphapyridin are readily oxidized to characteristic cherry-reddish products by a number of chemical oxidants as well as by electrolytic oxidation. The identity of the products has not been established, but circumstantial evidence suggests what they are. The products are the same regardless of the oxidizing agent used, and are therefore derivatives of sulphanilamid (or sulphapyridin) and not of the reagent used to oxidize it. In the oxidation four equivalents are consumed per mole of sulphanilamid oxidized, which points to the conclusion that the primary end-product of oxidation is nitroso-benzene sulphonamid. Among the agents used are ceric sulphate, chlorine water, sodium bismuthate, MnO_2, $KMnO_4$, ferric-ortho phenanthroline, PbO_2, and H_2O_2 (with Fe^{++} as catalyst). The last two are especially effective. Less intense oxidants, such as ferricyanide, I_2, $K_2Cr_2O_7$, vanadic acid, thallic sulphate, do not attack sulphanilamid or sulphapyridin rapidly at room temperature. Ferric ion is reduced to a slight extent. Bromine is instantly consumed by bromination of the ring.

It proves to be possible to measure the oxidation intensity of the products by platinum or gold electrodes. The products are rather unstable and do not give steady potentials. The potential falls rapidly and conventional curves characteristic of stable reversible systems are not obtained by titration. Nevertheless, there is fair reproducibility of potentials and rather good agreement among several different electrodes in the same solution. Approximate agreement of potentials is obtained with different oxidizing agents at the same pH levels. These features are regarded as justifying the belief that the observed potentials arise from and represent finite ratios of electromotively active substances, and so constitute significant and characteristic intensity levels of the substances from which the products are formed. If this belief proves to be correct, the measurement of potentials should be an important criterion in the search for new therapeutic agents of this type.

The relation of the observed potentials to "normal" potentials of the systems has not yet been established. Sulphanilamid concentration has no effect upon the potential, and the parent substance is therefore not a member of the electromotive pair. It is probably a fairly safe guess that the reversible electrode couple

[4] Fox, German and Janeway, *Proc. Soc. Exp. Biol. Med.*, 40: 184, February, 1939; and Warren, Street and Stockingen, *ibid.*, 208.

[5] *Proc. Soc. Exp. Biol. Med.*, 40: 640.

is composed of the hydroxyl amin and nitroso derivatives or the corresponding semi-quinone free radicals. The following evidence may be cited in support of this conclusion. Neither aniline nor nitrobenzene are active toward electrodes, while the corresponding intermediates, phenyl hydroxylamin and nitroso benzene, are active. Conant and Lutz[6] measured the potential of an equimolar mixture of the two last-named substances in 0.1 N HCl, (+0.605 v.). On oxidizing a solution of aniline in the same solvent by PbO_2 we find an initial potential about 0.1 v. higher which rapidly falls to and below this "normal" value. This behavior would be expected if the oxidation products were a mixture of the hydroxyl amin and nitroso forms, with the nitroso derivative decomposing at a faster rate.

The measured potentials of oxidized sulphanilamid solutions, as might perhaps be expected from the intense oxidants needed to form them (though there is no necessary connection), indicate an astonishingly high oxidizing intensity for these products. At pH 4.6 the plateau potential (E_h) of sulphanilamid oxidant is +0.59 v. At pH 1.8 (0.1 N H_2SO_4) the potential of sulphanilamid oxidation by ceric ion is +1.07 v. Measurement of potentials at pH 7 has not been successful for technical reasons. It is of interest, and is perhaps significant, that the potential of sulphapyridin at pH 4.6 is 30 or 40 mv. higher than that of sulphanilamid. For the potential measurements I am indebted to Dr. E. S. Hill.

The oxidation products are highly reactive, and fortunately the intensity levels indicated by the electrode potentials can be confirmed in a rough but convincing way by chemical reactions. The oxidized products are quickly reduced by hydroquinone, diphenylamine, p-phenylene diamine, p-amino phenol and in part by ortho-tolidine but not by benzidine, in part by iodide ion (with liberation of I_2) and by ferrous ion. They are also promptly reduced by oxyhemoglobin, which is thereby oxidized to methemoglobin, and also to other unknown products which are suggestive of the brown pigments observed in the blood of cyanotic patients treated with sulphanilamid. The intensity levels and potentials of the oxidation products of sulphanilamid therefore lie above those of the reductants named. It follows also that if these or other more reducing substances be present with sulphanilamid when it undergoes oxidation, only these and not sulphanilamid will appear to be oxidized. Metabolites activated by cells, many cell constituents and substances present in peptone broth culture media are such reducing substances. In their presence bacteria might be more or less protected from the effect of slowly oxidized sulphanilamid. But if not at once reduced, the activity and oxidation intensity of the products of sulphanilamid are such that they would certainly exert on bacteria much the same lethal effects as would like concentrations of I_2 or Br_2. (The oxidation products are, of course, highly bactericidal *in vitro*). Because of the presence in tissues and tissue fluids of many reducing substances it would appear to be hopeless to expect to find the oxidation products of sulphanilamid in living cells; perhaps it may be possible to find them in dead tissues.

The question naturally arises: Is it possible that a substance so difficult of oxidation as sulphanilamid could be attacked by oxygen in living cells? The same question might be asked about acetic acid or sugar or fat. To be sure, these are made reactive by enzymes, while there is no evidence that enzymes activate sulphanilamid. But activation of the drug is not necessary. It may be recalled that oxygen has an oxidizing intensity represented by +1.23 v. (at one atmosphere pressure and at 0 pH). For comparison with our measurements of sulphanilamid at pH 4.6, the corresponding value for O_2 at one atmosphere is +0.95 v. and at 50 mm Hg pressure +0.78 v. The energy factor raises no difficulty. Confirmation of this conclusion is found in the fact that epinephrine is rapidly oxidized in the body. Its potential (Ball, *Jour. of Biol. Chem.*, 102: 691, 1933) is in the same region as that observed in sulphanilamid oxidation.

But the question remains: How could so intense an oxidant as necessary to oxidize sulphanilamid (or adrenalin) be formed in living cells? A tentative answer may be formulated somewhat as follows. The lethal oxidizing intensity of O_2 would presumably exert itself on all respiring cells if the oxygen molecule were to react by the formation of two molecules of water; it is this reaction for which O_2 has a potential of 1.23 v. This possibility is avoided by the formation of H_2O_2 instead of water. For the formation of H_2O_2 the potential of O_2 is only +0.26 v. at pH 7. Without catalysts H_2O_2 is strangely inert at low concentration. But with metal catalysts present in cells it is an even more intense oxidant than O_2. The enzyme catalase, however, rather promptly and completely destroys H_2O_2, thereby protecting the cell from higher than about 0.26 v. (the level of cytochrome). If, however, substances are introduced which are freely permeable and are capable of oxidation even to a slight extent to reactive products the potentials of which are high, then such active oxidants may attack and oxidize functional components of the cell which are otherwise protected from O_2 and H_2O_2. The potential of the oxidation products of sulphanilamid at pH 7 (calculated from values observed at pH 4 to 5) is +0.45 v., which is considerably higher than the normal potential of any other organic substance yet measured (except sulphapyridin and adrenalone). Every reactive reducing system in cells would be attacked by so energetic an oxidant. Among the cell components which would

[6] *Jour. Am. Chem. Soc.*, 45: 1059, 1923.

be oxidized are catalase (a ferrous hemin complex), hemoglobin, glutathione, sulphhydryl groups, ascorbic acid and so forth. With catalase more or less inactivated, H_2O_2 would accumulate locally. And H_2O_2 with ferric or ferrous ion (present in serum and tissues) is a rapid oxidant of sulphanilamid and of sulphapyridin. Once slowly started, more and more of the toxic oxidation products would thus be formed, in proportion as O_2 is available and H_2O_2 is produced. Bacteria in the blood stream and in regions of rich blood supply should be most exposed to the bactericidal effects. The appearance of methemoglobin is evidence of activity in the blood. Conversely, bacteria sequestered in tissues or locations (abscesses) with poor blood supply may be expected to be less accessible to the bactericidal effects. The relative immunity of host tissues to toxic effects is perhaps due to their lower oxygen tension, their higher metabolism and to higher catalase content. A dominant reducing environment should protect tissues from the sulphanilamid products in the same way as bacteria are protected from I_2 in Clark's demonstration above mentioned. In general, these hypothetical expectations appear to be in accord with clinical and experimental experience.

As the writer sees the evidence now available, the probable mode of action of sulphanilamid is that outlined in the above statement. The drug provides a mechanism by which the sterilizing oxidation intensity of molecular oxygen is applied nearly at its maximum to bacteria and unavoidably also to some extent to host cells. It is not surprising that toxic as well as therapeutic effects are observed from the use of such substances.

If the ideas here advanced are even in part correct, the new era of bacterial chemotherapy will be directly concerned with that fund of systematic information dealing with oxidation-reduction potentials and with the relation of molecular structure of organic substances to potential levels, as well as with the fascinating complexities of reactions that occur particularly among the intermediate oxidation stages of nitrogenous compounds.

From this store of information a number of predictions can at once be made. For example, if high potentials are desired, ortho rather than para substitution of the oxidizable group may be preferable. It is unlikely that the sulphonic acid group is essential to activity, though it does raise potentials and increase solubility. Hydroxyl rather than amino compounds may be useful. The applicability of these and other similar ideas will be explored and tested in future work in this laboratory.

SCIENTIFIC EVENTS

FELLOWSHIPS IN THE NATURAL SCIENCES OF THE NATIONAL RESEARCH COUNCIL

THE National Research Fellowships Board in the Natural Sciences of the National Research Council has made the following appointments for the academic year, 1939–1940:

John Nathaniel Adkins (Ph.D., seismology, University of California, 1939). The Massachusetts Institute of Technology. "The Electromagnetic Response of an Ellipsoid Imbedded in a Conducting Material."

Daniel I. Axelrod (Ph.D., tertiary paleobotany, University of California, 1939). The United States National Museum, Washington, D. C. "The Late Tertiary Floras of the Great Basin Province."

Richard Henry Bolt (Ph.D., physics, University of California at Los Angeles, 1939). The Massachusetts Institute of Technology. "The Wave Theory Approach to Room Acoustics."

Herbert Leonard Eastlick (Ph.D., chemistry, Washington University, 1936). The University of Chicago. "A Study of Pigmentation, Muscle Development, etc., by Means of Reciprocal Heteroplastic Transplants between Different Species of Avian Embryos."

Eugene Henderson Eyster (Ph.D., physical chemistry, the California Institute of Technology, 1938). The University of Michigan. "The Application of Infra-red Spectroscopy to Problems of Molecular Structure."

Frank Junior Fornoff (Ph.D., chemistry, the Ohio State University, 1939). University of California. "The Establishment of Subgroups within the Rare Earth Group of Elements by Means of Heat Capacity Studies of Rare Earth Salts."

Jackson Walter Foster (Ph.D., soil microbiology, Rutgers University, 1939). The University of Cambridge, England. "Respiration Studies on Filamentous Fungi."

Orville Goodwin Harrold, Jr. (Ph.D., mathematics, Stanford University, 1936). The University of Virginia. "The Structure of Semi-schlicht Images of a Compact Metric Space with Especial Reference to (k, 1) Transformations. The Topology of Rectifiable Curves."

Norman Harold Horowitz (Ph.D., embryology, the California Institute of Technology, 1939). Stanford University and Hopkins Marine Laboratory. "An Investigation of the Respiratory Enzymes of Developing Marine Eggs."

John Oliver Hutchens (Ph.D., zoology, the Johns Hopkins University, 1939). The Carlsberg Laboratorium, Copenhagen, Denmark. "The Carbon and Nitrogen Metabolism of Chilomonas Paramecium."

Francis Philip Jahn (Ph.D., physical chemistry, New York University, 1938). Princeton University. "Azoethane: Preparation, Pyrolysis and Photolysis, Molecular Spectra and Thermodynamic Properties of Azoethane."

Ralph Ernest Lincoln (Ph.D., genetics, the Iowa State College, 1939). Cornell University. "Mutation in *Bacterium stewartii* Including Its Pathogenicity on Maize."

John Lafayette Magee (Ph.D., chemistry, University of

Wisconsin, 1939). Princeton University. "A Theoretical Treatment of Photochemical Processes."

Joseph Miller (Ph.D., psychology, Yale University, 1939). Stanford University. "An Analysis of the Temporal Gradient of Reinforcement in Human Subjects and Its Application to Serial Behavior Sequences."

Jack Edgar Myers (Ph.D., botany, University of Minnesota, 1939). The Smithsonian Institution, Washington, D. C. "A Study of the Development of Photosynthetic Activity, Especially as it Relates to the Development of the Plant Pigments."

Myron Hiram Nichols (Ph.D., physics, the Massachusetts Institute of Technology, 1939). Princeton University. "Thermionic Work Function of Thoriated and Caesiated Tungsten for the Different Crystal Faces."

John Booth Peterson (Ph.D., soil fertility, the Iowa State College, 1936). University of California. "The Relation of the Composition of Soil Binding Material to the Stability of Soil Aggregates and the Resistance of Soils to Erosion."

Jean Barnett Piatt (Ph.D., zoology, Yale University, 1937). The University of Utrecht, Holland. "The Specificity Relationship between Individual Motor Fibers and Their Normal Muscle Field in Regenerated Forelimbs of Triturus Pyrrhogaster."

John Robert Raper (Ph.D., general biology, Harvard University, 1939). The California Institute of Technology. "The Sexual Mechanism in the Saprolegniales."

Julian Seymour Schwinger (Ph.D., physics, Columbia University, 1939). University of California. "The Theory of Nuclear Forces."

Dorothy J. Shaad (Ph.D., experimental psychology, Bryn Mawr College, 1934). The Harvard Medical School. "The Value of Controlled Bifoveal Stimulation in the Correction of Anomalous Visual Projection."

Wave Henry Shaffer (Ph.D., physics, the Ohio State University, 1939). The University of Chicago. "Interpretation of Band Spectra of Polyatomic Molecules."

Saul Winstein (Ph.D., organic chemistry, the California Institute of Technology, 1938). Harvard University. "Studies in the Walden Inversion and the Allylic Rearrangement."

George Prior Woollard (Ph.D., structural geology, Princeton University, 1937). Lehigh University. "Investigations of the Geologic Structure beneath the Atlantic Coastal Plain and Related Areas by Means of Seismic and Gravity Profiles."

EXHIBIT OF THE AMERICAN GEOGRAPHICAL SOCIETY

A COMPREHENSIVE exhibit of geographical data, maps, charts and tools of geographical research was opened on May 19 by the American Geographical Society of New York City. The exhibit, which will be free to the public while the World's Fair is in progress, was opened by W. Redmond Cross, chairman of the council of the society, at a private showing for the society's fellows. Captain Robert A. Bartlett, Arctic explorer, was a special guest for the occasion.

The exhibit is divided into sections dealing with exploration and field research, geographical fundamentals, New York City, primitive and historical maps, United States Coast and Geodetic Survey, the polar regions, photographic mapping, map of Hispanic America, economic and social conditions in the United States and international affairs. It will be open to the public from 2 P.M. to 5 P.M. daily except Mondays and Thursdays throughout the World's Fair season.

The society has prepared the exhibit as its share in providing features of unusual interest for visitors to the World's Fair. This is the first time in its eighty-six years of history that it has offered an exhibit of this nature to the general public.

Among the features of the exhibit are:

1. A map mounted on a section of the earth's surface which, if complete, would be nearly 132 feet in circumference. This section shows the actual curvature of the earth on a scale of 1: 1,000,000 and is covered with a map on that scale of the widest part of South America, from the Pacific coast of Ecuador and Peru to the Atlantic coast of Brazil. On this map, on the same scale, Mt. Everest would be 0.35 inch high and the sun would be about as far away as Philadelphia.

2. Field equipment for a modern high-altitude expedition. A nine-pound, two-man tent so designed that the stronger the wind blows the more resistant the tent becomes, air survey equipment, high-altitude stoves and radio equipment.

3. The Flyers' and Explorers' Globe, bearing the signatures and showing the routes of many famous explorers and 'round the world and transatlantic flyers. Those represented include Lindbergh, Post and Gatty, Byrd, Nansen and Wilkins.

4. New York City in maps. From the earliest plan of New Amsterdam to present-day maps illustrating the distribution and classification of buildings, the city's highway, subway and elevated, and railroad terminal systems, its complicated interlacing of power lines and telephone and telegraph offices.

5. Geographical background of the European situation. Maps which illustrate the boundaries in Europe according to language, physical and economic characteristics, religions, major soil regions, and which show political boundaries during five periods of European crisis.

6. Examples of primitive and historical maps, including an Eskimo relief map carved in driftwood and a Turkish map of the Atlantic Ocean and its coasts (1513) believed to be based on a lost map by Columbus and published at the suggestion of the late President Kemal Ataturk of Turkey.

7. Mapping by photography. Illustrations of modern methods and special mechanical equipment developed at the American Geographical Society for doing survey work by airplane and camera in a fraction of the time required by the older methods. A typical survey of an unmapped, almost unknown country, northernmost Labrador. Illustration of the work and details of the functioning of the

new 9-lens aerial camera developed by the United States Coast and Geodetic Survey.

8. The "Millionth Map" of Hispanic America. A project which has occupied the society for eighteen years—the mapping of the whole of Hispanic America to conform to the standard of the International Map of the World on the scale of 1: 1,000,000. This is the largest map project ever undertaken by a private organization and is now nearly complete.

ARCHEOLOGICAL EXCAVATIONS OF THE FIELD MUSEUM OF NATURAL HISTORY

THE first exhibition of archeological material excavated from the ruins of villages inhabited a thousand years ago and more by the prehistoric basket-maker Indians of Southwestern Colorado was opened on May 26 at the Field Museum of Natural History. The objects were recovered by the 1938 Field Museum Archeological Expedition under the direction of Dr. Paul S. Martin, chief curator of anthropology. Dr. Martin and associated archeologists have spent months in intensive study of this material, and most of it, dug up in fragments, has had to be carefully pieced together in preparation for exhibition. The results of the research, both in the field and in the museum laboratories, are shortly to be published in an illustrated book to be issued by Field Museum Press.

There is exhibited a painting by Arthur G. Rueckert showing the restoration of a basket-maker village as it must have appeared when it was inhabited by American aboriginals about A.D. 860. There are examples of rare red-on-orange pottery of a type unknown to archeologists until a few years ago. This dates from about A.D. 700, or possibly earlier, and it has not yet been determined where it was first made. The use of designs in red on orange contravenes accepted traditions. Usually the pottery is plain gray, or is marked with black designs of a simple nature on a gray background. In addition to the pottery, the display includes other objects used in the daily lives of the basket-maker Indians, who probably perished before white men reached this continent. Included are various kinds of tools and implements made of bone and stone—awls, axes, mauls, corn-grinding mills and ornaments. Difficulties in making the restoration are described by Dr. Martin as follows:

> Since these villages had been exposed to the rains and snows of more than a thousand years before the museum expedition arrived on the scene, all the perishable objects—such as basketry, cloth, sandals, matting and wooden materials—have long since rotted away. Thus the archeologist is confronted with the problem of reconstructing history from only three classes of objects: pottery, bone and stone. Imagine how trying it would be for an archeologist a thousand years from to-day to have to piece together a complete story of the complex civilization of America from only broken dishes, rusty tools of which he did not know the uses, and empty tin cans. In spite of this difficulty, however, we have managed to reconstruct a reasonably clear chronology of events in basket-maker times.

The expedition uncovered a number of great kivas or underground ceremonial chambers, including the largest structure of the type ever found—83 feet in diameter. These, together with subterranean pit-houses, barracks-like rows of surface houses and other architectural types, are restored in the painting of the village.

Eight summers have been spent in the excavation of the basket-maker sites in Colorado. The ninth expedition, sponsored by Stanley Field, president of the museum, planned to resume the work early this month. This time operations will be concentrated upon the excavation of some ruins near Glenwood, New Mexico. The new sites belong to what is known as the Mogollon culture, and investigations will be conducted to determine whether or not there was a cultural connection between the Mogollon and basket-maker cultures.

JOINT MEETING OF THE ROYAL METEOROLOGICAL SOCIETY AND THE AMERICAN METEOROLOGICAL SOCIETY

A JOINT meeting of the Royal Meteorological Society and the American Meteorological Society will be held in Toronto, Canada, on August 28 and 29.

Professor D. Brunt, F.R.S., of the Imperial College of Science and Technology, and Dr. W. Elsasser, of the California Institute of Technology, will read papers on radiation.

Dr. J. Bjerknes, of Bergen, Norway; Dr. H. R. Byers, of the United States Weather Bureau; Professor C.-G. Rossby, assistant chief of the Weather Bureau, and Dr. S. Petterssen, of the Massachusetts Institute of Technology, will read papers on the extra-tropical cyclone. Ample time will be provided for the discussion of these papers.

There will be a visit to the David Dunlap Observatory, and a dinner will be given by the University of Toronto to the delegates and their ladies.

Accommodation will be provided at one of the university residences, at $1.00 per day, and meals may be obtained nearby.

The sessions will be held in the Royal Ontario Museum, and the meeting will close in time for delegates to join the excursion of the American Geophysical Union from Kingston, Ont., on the morning of August 30.

GRANT FOR PHILADELPHIA TO AID AMATEUR STUDIES AND ADULT EDUCATION IN SCIENCE

THE Carnegie Corporation of New York has made a grant to the American Philosophical Society to undertake a broad survey of adult education in science, using the Philadelphia region as an experimental area. The purpose of the investigation will be to promote

knowledge in the sciences and in scientific methods through new means and to encourage the participation of amateurs.

To guide this experiment the American Philosophical Society has appointed a committee on organization, including Edwin G. Conklin, executive vice-president of the society and professor emeritus of biology at Princeton University, as chairman; Anton J. Carlson, physiologist, the University of Chicago; Karl K. Darrow, the Bell Telephone Laboratories; Luther P. Eisenhart, professor of mathematics, Princeton University; C. E. Kenneth Mees, director of research, the Eastman Kodak Company; Harlow Shapley, director of the Harvard Observatory; W. F. G. Swann, director of the Bartol Research Foundation of the Franklin Institute; Harold C. Urey, professor of chemistry, Columbia University, and Roland S. Morris, president of the American Philosophical Society.

The survey will be conducted by an executive staff of scientific consultants. It will study educational programs already in progress in many institutions and will also determine the contribution made by some one hundred and eighty amateur organizations in the Philadelphia area, including astronomers, telescope makers, natural history and hiking clubs, photographic groups and others. Special emphasis will be placed on the participation of persons in discussion forums, laboratory courses, museum tours and field trips.

A unique feature of the plan is the cooperation to be secured from local institutions and organizations, including the Philadelphia Board of Public Education, more than sixteen colleges and universities, the Franklin Institute, the Academy of Natural Sciences, the Wagner Free Institute of Science, the Museum of the University of Pennsylvania, the Delaware Valley Ornithologists Club, the Rittenhouse Astronomical Society and many others.

The Executive Staff of the Committee on Education and Participation in Science has as its chairman Roland S. Morris and as its executive secretary in charge of the survey W. Stephen Thomas, recently director of education of the Academy of Natural Sciences. The members of the staff who will act as consultants in their various fields are: Roger Conant, zoology, curator of the Philadelphia Zoological Gardens; Dr. John M. Fogg, Jr., botany, University of Pennsylvania; Dr. Serge A. Korff, physics and astronomy, Bartol Research Foundation, and Dr. Edward E. Wildman, science education, of the Philadelphia Board of Public Education.

SCIENTIFIC NOTES AND NEWS

THE American Association for the Advancement of Science will hold its hundred and fourth meeting at Milwaukee from June 19 to June 24, under the presidency of Professor Walter B. Cannon, of Harvard University. With it will meet a number of affiliated societies. The full preliminary program of the meeting, compiled by the permanent secretary, was published in the issue of SCIENCE for May 26.

THE list of birthday honors of the King of England includes a knighthood conferred on Dr. Owen Richardson, professor of physics at the University of London, from 1906 to 1914 professor of physics at Princeton University.

THE Belgian Society of Tropical Medicine, which has charge of health work in the Belgian Congo, has elected Dr. Alfred C. Reed, director of the Institute of Tropical Medicine of the University of California, a corresponding member.

DR. SELMAN A. WAKSMAN, microbiologist of the New Jersey Agricultural Experiment Station, has been elected a foreign member of the Royal Swedish Academy of Agriculture.

AT the annual alumni reunion dinner of the Massachusetts Institute of Technology, Dr. Dugald C. Jackson, professor emeritus, formerly head of the department of engineering, was made an honorary member of the Alumni Association.

AT the commencement exercises of the University of Missouri the degree of doctor of laws was conferred on Dr. Earl Raymond Hedrick, provost of the University of California at Los Angeles and vice-president of the university.

STEVENS INSTITUTE OF TECHNOLOGY, at its sixty-seventh commencement on June 10, conferred the honorary degree of doctor of engineering on William S. Knudsen, of Detroit, president of the General Motors Corporation; on Ole Singstad, chief engineer of the New York City Tunnel Authority; on William LeRoy Emmet, of Schenectady, N. Y., who has been associated with the General Electric Company since 1887, and on Alexander Graham Christie, professor of mechanical engineering at the Johns Hopkins University and president of the American Society of Mechanical Engineers. Mr. Knudsen delivered the address to the graduating class.

AT the forty-fifth annual commencement of the North Dakota Agricultural College, the honorary degree of doctor of agriculture was conferred on Professor C. B. Waldron, professor of landscape gardening and forestry, formerly professor of horticulture and dean of the School of Agriculture of the college, and upon Professor H. L. Bolley, botanist and plant pathologist of the College Experiment Station.

PROFESSOR H. B. WALKER, head of the division of

agricultural engineering at Davis of the University of California, will be presented at the thirty-third annual meeting to be held in St. Paul, Minnesota, from June 19 to 22 with the John Deere Medal of the American Society of Agricultural Engineers in recognition of his achievements in "the application of science and art to the soil."

THE seventieth birthday of Dr. H. H. Dixon, professor of botany at Trinity College, Dublin, was celebrated by the presentation of a congratulatory address. Nearly three hundred names were appended, including those of his colleagues, of representatives of the colleges of Eire and Northern Ireland, of the universities of Great Britain and of many European and American universities. The presentation was made by the provost, who spoke of Professor Dixon's occupancy of the chair of botany, to which he succeeded thirty-five years ago, on the retirement of the late Professor Wright.

DR. W. D. CAIRNS, professor of mathematics at Oberlin College for the past forty years, retires this month. His address as secretary-treasurer of the Mathematical Association of America remains as previously, Oberlin, Ohio.

AT the University of Colorado, following the retirement of Professor Francis Ramaley, Dr. Gordon Alexander has been promoted to a professorship and will become head of the department of biology, and Dr. Edna Louise Johnson has been promoted to a professorship in biology. Dr. Ramaley will continue at the university as editor of publications.

DR. PAUL BARTSCH, curator of the Division of Mollusks, Cenozoic Invertebrates, Helminths and Corals of the U. S. National Museum and since 1899 professor of zoology at the George Washington University, will retire this month from his chair at the university with the title emeritus.

DR. JOHN RATHBONE OLIVER, having reached the age of sixty-seven years, is retiring as associate in the history of medicine at the Johns Hopkins University.

DR. ALFRED NEWTON RICHARDS, professor of pharmacology at the University of Pennsylvania, was elected on June 5 vice-president of the university in charge of medical affairs to fill the vacancy occasioned by the death of Dr. Alfred Stengel on April 10. He will take office on July 1. Dr. Richards will retain his professorship of pharmacology both in the School of Medicine and in the Graduate School of Medicine.

DR. DIRK BROUWER has been promoted to an associate professorship of astronomy at Yale University.

AT the University of London, Professor W. E. Le Gros Clark, since 1934 professor of anatomy in the University of Oxford, has been appointed as from October 1 to the chair of anatomy tenable at University College. Dr. Samuel Nevin has been appointed to the chair of pathology of mental disease tenable at the Maudsley Hospital. He will take up his work in September.

THE Board of Managers of the Wistar Institute of Anatomy and Biology have announced the following elections and new appointments: *President,* Dr. Esmond R. Long, director of the Henry Phipps Institute and professor of pathology at the University of Pennsylvania; *Members of the Board of Managers,* Dr. Alfred Newton Richards, professor of pharmacology at the University of Pennsylvania and vice-president in charge of medical affairs, and William H. DuBarry, vice-president and assistant to the president; *Executive Director,* Dr. Edmond J. Farris, associate in anatomy in charge of operations, the Wistar Institute.

JOSEPH R. SLEVIN, curator of herpetology in the California Academy of Sciences, arrived on May 9 in Chiriqui Province, Panama, where he plans to spend several months collecting reptiles and amphibians. This is a continuation of work previously undertaken in the Central American region.

DR. ERNST A. BESSEY, professor of botany and dean of the Graduate School at the Michigan State College, East Lansing, has leave of absence for the next college year to become visiting professor of botany at the University of Hawaii during the occupancy of the Bishop professorship at Yale University by Professor Harold St. John. Dr. Bessey will leave in August, returning in about a year.

DR. MAX BERGMANN, member of the Rockefeller Institute for Medical Research, delivered the Edward Gamaliel Janeway lecture at Mount Sinai Hospital, New York City, on May 16. His subject was "Some Biological Aspects of Protein Chemistry."

AT the annual Harlow Brooks medical program of the Washington Square Medical Society on April 20 Dr. Louis F. Bishop opened the session with an address entitled "Reminiscences of Dr. Harlow Brooks" and Dr. Lewellys F. Barker, Baltimore, delivered the memorial lecture on "The Diagnosis and Treatment of Vitamin Deficiencies."

DEAN FRANK C. WHITMORE, of the Pennsylvania State College, on May 19 gave the sixty-sixth Barnwell address at the Central High School of Philadelphia. Others who have spoken in this series since 1922 are Edwin E. Slosson, Michael I. Pupin, Henry Fairfield Osborn, William Beebe, Wm. F. G. Swann, Clyde Fisher, Karl Taylor Compton, Aleš Hrdlička, Isaiah Bowman and Edwin G. Conklin.

DR. ALEŠ HRDLIČKA, of the U. S. National Museum, lectured at University College, London, on May 31 and June 1. The subjects of the lectures were "The Pres-

ent Status of Our Views on Human Evolution" and "The Racial Fallacies and Realities of European Peoples."

DR. GEORGE W. LEWIS, director of aeronautical research of the National Advisory Committee for Aeronautics of the United States, delivered in the lecture hall of the British Institute of Mechanical Engineers on May 24 the twenty-seventh Wilbur Wright memorial lecture entitled "Some Modern Methods of Research in the Problems of Flight."

THE fifth International Congress for the Unity of Science will be held at Harvard University from September 3 to 9. Rooms will be available at $1.25 per day per person. Arrangements can be made through Dr. W. Van O. Quine, Harvard University, Cambridge, Mass. Contributions to the congress are as follows: Donors, $25.00 upwards; active members, $5.00; students and relatives of members, $1.50. All who would like to receive later notices of the congress should send their names to Professor Charles W. Morris, University of Chicago.

AT the annual meeting of the Midwestern Psychological Association held recently at the University of Nebraska, the following new officers for the year 1939–40 were announced: *President,* J. P. Guilford, University of Nebraska; *Secretary-Treasurer,* Robert H. Seashore, Northwestern University, and *Member of the Council,* N. R. F. Maier, University of Michigan. The fifteenth annual meeting will be held on May 3 and 4, 1940, at the University of Chicago.

THE House of Representatives on May 24 completed Congressional action on a bill to authorize the construction of two new vessels for the Coast and Geodetic Survey at a cost of $1,425,000. The bill carries no appropriation.

THROUGH the courtesy of Mrs. Margaret W. Biddle the California Institute of Technology has been given the chemical library of Professor Henry Chalmers Biddle, formerly dean of the College of Pharmacy of the University of California. The library consists mainly of books and journals dealing with organic chemistry.

THE Rockefeller Foundation has appropriated for the Johns Hopkins Medical School a ten-year grant of $350,000 to establish a department of preventive medicine.

DR. ROBERT S. CARROLL, founder, owner and medical director of Highland Hospital for nervous and mental disorders at Asheville, N. C., has presented the hospital to Duke University, Durham, to be developed as the therapeutic unit of a new department of psychiatry. If at any time in the future the university decides that operation of the hospital in Asheville is not practicable, the property and equipment may be disposed of, but the proceeds therefrom must be used for the department. Dr. Carroll will remain the medical director of the hospital for five years, during which time a gradual interchange of personnel between the institutions will be effected.

ACCORDING to an announcement printed in the *Journal* of the American Medical Association, research on cancer at the University of Wisconsin will be centralized in a new building now in process of construction. Funds amounting to about $240,000 have been provided for the building by a special bequest, by a contribution from the Wisconsin Alumni Research Foundation and by a PWA grant of $108,000. It will be 102 feet long and 50 feet wide and will be connected with the Memorial Service Institutes of the university and the Wisconsin General Hospital. Two floors will be devoted to biologic research, one to x-ray diagnosis and the first floor to radiologic research and treatment. The new building can not offer space to all the work on cancer of the departments of zoology, plant pathology, agricultural chemistry, physics, chemistry and various departments of the medical school, but it will have conference rooms and will serve as a clearing house to unify the varied activities. In the Wisconsin General Hospital cancer patients from all parts of the state are received, making all types of the disease accessible to research workers. The entire development is being directed by a committee of the Graduate School consisting of Dr. William S. Middleton, dean of the Medical School, *chairman;* Dr. Edwin B. Fred, dean of the Graduate School, and Dr. Michael F. Guyer, professor of zoology. Dr. Walter J. Meek, professor of physiology and associate dean of the Medical School, is chairman of the building committee.

THE preparation of a new "Nomenclator Zoologicus" is now approaching completion. It is estimated that the work will comprise some 225,000 entries, of which about 5,000 appear to have been omitted from all previous publications of this character. It is proposed to publish the work in 4 volumes of nearly 1,000 pages each, which it is hoped it will be possible to issue at intervals of about six months. The Zoological Society of London has borne the cost of preparation (approximately £1,800), but the council of the society does not feel justified in incurring further expenditure, which would involve an additional £3,600. However, with the aid of various grants from outside sources, the editor, Dr. Sheffield Neave, has himself now been able to arrange for the printing and publication of the work.

DISCUSSION

PACIFIC ENTOMOLOGICAL SURVEY

THIS note has been prepared to clarify the meaning of the term "Pacific Entomological Survey" and thus make unnecessary the confusion indicated in correspondence and printed papers. The survey was organized in Honolulu in 1926 through a cooperative agreement, for a five-year period, 1927–1932, between Bernice P. Bishop Museum, the Hawaiian Sugar Planters' Experiment Station and the Association of Hawaiian Pineapple Canners, and had for its purpose "collecting, mounting, sorting and identifying insects of the Pacific islands (including Hawaii), preparing lists and descriptions for publication and publishing the same." As the director of the survey, the committee in charge appointed C. F. Baker, dean and director of the College of Agriculture, University of the Philippines. On the death of Dr. Baker on July 28, 1927, E. P. Mumford, Commonwealth fellow, University of California, was chosen as his successor, and in association with A. M. Adamson, now professor of entomology at the Imperial College of Tropical Agriculture (Trinidad), and local assistants, collected insects in the Marquesas Islands (January, 1929, to April, 1930; Adamson collected in the Society Islands, September to December, 1928). At the close of the period of cooperative agreement (1932), the organization was extended for one year (1933) and then disbanded with the understanding that papers based on these collections in preparation by specialists in entomology would be published by Bishop Museum and credited to the Pacific Entomological Survey (most of these papers have been issued as Bulletins 98, 133, 114, 142, in press). Since 1933, field studies of the insects of the Pacific Islands have been continued, organized and financed by institutions in Hawaii. In excess of 100,000 specimens have been brought to Bishop Museum from the Mangarevan Islands, Austral Islands, Tuamotu Archipelago, Rapa, Society Islands, Equatorial Islands, etc., in 1934; Micronesia in 1935–1936; Guam in 1936; Fiji, New Zealand in 1937; Fiji in 1938.

Some time after the official termination of the Pacific Entomological Survey and while studies of the Marquesan insects were in the process of publication in Honolulu, there was organized, and the name registered, a "Pacific Entomological Survey" under the directorship of E. P. Mumford, with headquarters at Oxford. Unfortunately, the name applied to the new "Survey" is the same as that long in use in Hawaii, and to avoid misunderstanding it is appropriate to note that the two organizations are entirely unrelated in present personnel, finance and program; that the new "Survey" is distinct from the survey organized in Hawaii, and has no control over the collections made in the Marquesas and Society Islands by Mumford, Adamson, Whitten, Tauraa and Le Bronnec during the period 1928–1933, nor over the publications resulting from their study. All correspondence pertinent to the original survey should be addressed to Bernice P. Bishop Museum, Honolulu.

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DIURNAL CYCLE OF HEAT RESISTANCE IN PLANTS

A DAILY cycle of heat resistance in plants that does not appear to have been reported in the literature has been discovered in the several species of field crops studied including corn, wheat, barley, sorghum and alfalfa.

In these studies the daily maximum resistance to heat was attained by plants at about mid-day and continued during the afternoon. The minimum resistance prevailed early in the morning. Resistance to heat increased in plants when they were exposed to light and decreased in the absence of light. One hour of light, following normal darkness of night, was long enough for plants to acquire a measurable and, in some cases, a marked amount of resistance to heat. Ordinarily plants reached their daily maximum heat resistance within four hours after exposure to daylight following normal night. Plants exposed to electric light during the night were more resistant to heat in early morning than those that had been in the dark during the night.

The loss of heat resistance in plants when exposed to darkness was slower than the gain of resistance in the presence of light.

Most of the investigations were made with young plants, although corn and sorghum were tested also in the flowering stage. Exposure to high temperature for five hours was sufficient clearly to indicate differential resistance. The degree of temperature required to distinguish differences in heat resistance depended upon the species and the condition of the plants.

The following data are presented as illustrations of the experimental results that have been obtained in these studies. Young wheat plants, grown in the greenhouse in January, when tested at 122° F. for five hours beginning at 8 A.M., were injured 68 per cent. as indicated by the proportion of tissue that was killed. In similar tests beginning at 1 P.M. the injury was 18 per cent. Young barley plants which received

no morning light preceding the test were injured 84 per cent., while those that had been exposed to the forenoon light preceding the test were injured 21 per cent. Wheat plants which had been three feet below a 200-watt Mazda light during the night were injured 24 per cent. when tested for five hours at 120° F., whereas similar plants that had been in the dark during the night were injured 70 per cent. by the treatment. Wheat that had been kept in the dark during the night and forenoon was injured 95 per cent. compared with 15 per cent. injury to plants that had been treated in the same way except that they were exposed to daylight for one hour immediately before the test. Corn plants in some cases exhibited increased resistance to heat following exposure to light for less than one hour. Wheat that had been in daylight throughout the forenoon was injured 10 per cent. by heat, whereas the plants that were prepared in the same way except for being in darkness one hour immediately preceding the test were injured 30 per cent. Sorghum in the heading stage was injured less by exposure to 150° F. for five hours beginning at 1 P.M. than to 140° F. for the same length of time beginning at 8 A.M.

The photosynthetic production of organic material suggests itself as an explanation for the increased resistance of plants to heat. It appears, however, that the amount of organic material that might be manufactured during the short exposure to light, which is needed to bring about a marked increase in resistance, would probably be insufficient to account for so much change in resistance. Perhaps a photochemical change or some other influence of light which can be induced quickly may be responsible for the increased resistance of plants to heat when they are exposed to light.

Investigations seeking an explanation for the phenomenon resulting in a daily cycle of heat resistance in plants are being continued.

H. H. LAUDE
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NIEVES PENITENTES NEAR BOSTON, MASSACHUSETTS

ON March 11, 12 and 13, approximately 11 inches of snow fell in the Greater Boston area. This, together with what had already fallen, made 14.2 inches of snow. For ten days following this storm, the temperature remained below freezing much of the time (Table 1). During this period the humidity was continuously low and there were several clear days (Table 1).

As these conditions are ideal for the formation of nieves penitentes, it is not surprising that on March 21, 22 and 23 the writer observed larger and more perfectly formed nieves than he had ever before seen around Boston. These features are usually found on the snow fields of lofty mountains. They have been described from the Himalayas,[1] Sierra Nevada,[2] Kilimanjaro[3] and also from the Andes,[4] where apparently they reach their greatest size and most perfect development.

TABLE 1

U. S. WEATHER BUREAU, BOSTON, MASSACHUSETTS

Date	Max. temp. F°	Mean temp. F°	Humidity at noon	Sunshine
March 14 ...	38°	30°	59	clear
" 15 ...	38°	30°	74	cloudy
" 16 ...	45°	36°	95	cloudy
" 17 ...	38°	32°	47	clear
" 18 ...	35°	29°	52	partly cloudy
" 19 ...	31°	24°	35	clear
" 20 ...	40°	32°	64	cloudy
" 21 ...	36°	30°	54	clear
" 22 ...	35°	28°	44	clear
" 23 ...	41°	31°	40	clear
" 24 ...	58°	46°	43	clear

As is shown in A of Fig. 1, a great many were

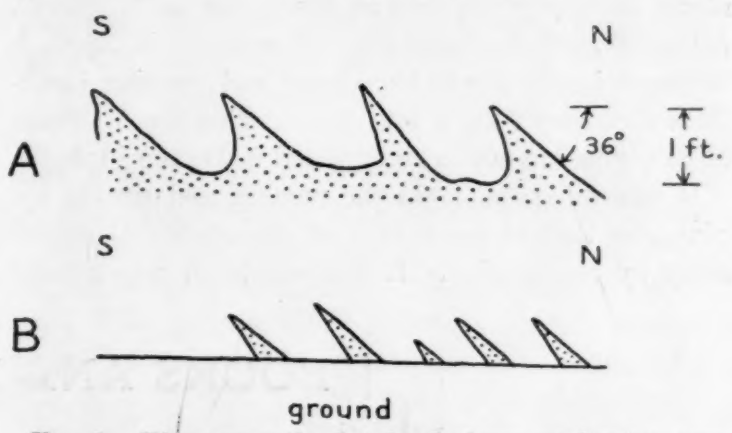

FIG. 1. Diagrammatic sketch of nieves penitentes near Boston, Mass. A—Pinnacles separated by snow. B—Pinnacles separated by bare ground.

approximately one foot high. They ranged, however, from a fraction of an inch to 2 feet in height. They were usually separated by pits, although some of the smaller ones were separated by east-west trenches. The pinnacles pointed toward the south, and the back slope (north facing) of many was approximately 36 degrees. Some of the pinnacles were separated from each other by bare ground, the result of complete melting and evaporation of the snow between them (B of Fig. 1). Many of the snow banks, which were originally of irregular shape, had cliffs two and three feet high on the south side and a flat slope on the north. As March 24 was a warm day with the temperature almost continually above 32 degrees (Table 1), much melting took place and the nieves were largely destroyed.

It is generally agreed that the nieves are produced

[1] W. H. Workman, *Zeitschrift für Gletscherkunde*, 3: 241–270, 1909.

[2] F. E. Matthes, Trans. Amer. Geophy. Union, 15th annual meeting: 380–385, 1934.

[3] F. Jaeger, *Zeitschrift der Gesellschaft für Erdkunde*, No. 2: 101–103, 1908.

[4] H. Meyer, *Zeitschrift der Gesellschaft für Erdkunde*, No. 2: 98–101, 1908. See also R. Hauthal, *Zeitschrift der Gesellschaft für Erdkunde*, No. 2: 95–98, 1908.

by the radiant heat of the sun. For their best development there must be a prolonged period with the temperature below freezing, low humidity and strong sunshine, together with an abundance of clear snow with surface irregularities. As these conditions are found as a rule only at high altitudes, the nieves penitentes are rare at or near sea level. The direction and angle of inclination of the pinnacles is a function of latitude. North of the equator they point south, south of the equator they point north, while on the equator they are vertical.

Their unusual size was due in part to the fact that they were formed in March. On March 21 Boston receives 1.3 times as much heat from the sun as it does on December 21. Assuming the necessary temperature conditions, low humidity and sunshine, it would take approximately 1.3 times as long to form nieves of any given size in December as in March. Although insolation would be still stronger in April, it is almost impossible to have snow and freezing conditions for more than a few days at this time. Hence large nieves are not to be expected in Boston in April.

It was estimated from the number and size of the pinnacles that as much as ¼ of this snow-fall wasted away by evaporation. If this condition was general over Massachusetts and New England, the loss of melt water due to this evaporation must have been considerable.

ROBERT L. NICHOLS

TUFTS COLLEGE

LANGUAGE DIFFICULTY

AMERICAN scientists, linguistically provincial, often have an apprehension about going to Europe to confer or conduct research in the scientific laboratories because of the "language difficulty." During the past year I had the occasion to converse with the directors (or persons in charge) of 66 biological field stations in 16 European countries (including Russia). In my experience, two thirds of the scientists interviewed spoke understandable English (universally, in Denmark, Sweden and the Netherlands), and of those who did not speak English, 80 per cent. spoke French, and the others German. There are good assurances, therefore, that if an American scientist does go to Europe on business, he can make himself understood scientifically, although there is no evidence that the percentage of political understanding is that high.

HOMER A. JACK

CORNELL UNIVERSITY

BOOKS AND LITERATURE

BIOLOGY

General Biology. A Textbook for College Students. By PERRY D. STRAUSBAUGH and BERNAL R. WEIMER. xi + 555 pp. 284 figs., including 13 colored plates. John Wiley and Sons, Inc., New York. 1938. $3.75.

To the writing of text-books on general biology there seems to be no end. The urge undoubtedly reflects the growing trend of formal instruction away from general botany and zoology toward general biology. This trend has been marked during the past two decades in America. It is noted in the high schools as well as in the colleges and universities. In fact, it probably began in the secondary schools. Such a trend is a phase of the larger movement toward general science courses. And the latter is a phase of the still larger movement toward the orientation course, the general college and what have you. Many teachers of science feel that all these movements tend to debase science. They tend to force higher educational interests to bow to more and more secondary and even elementary objectives. Maybe so, maybe not. At any rate the general biology course is with us. It will be with us for a long time. We must accept the challenge and set out to solve the associated problems. These are about the first major problems related to biological teaching that we have faced for a third of a century. Will the older generation of botanists and zoologists in our universities forget their prejudices and background, dig into a new batch of meristem and do this important job that society demands of the schools? That is the real challenge.

Literally dozens of authors have given us new books in the hope that they would supply an important aid in the above evolutionary movement. The most of such books are poor. Some are downright bad, or almost silly. Some are so extremely dilute as to challenge only the "man on the street." Others are so complex and technical as to stump a Nobel prize winner in biology. Some are so broad and general as to embrace the universe. Others are so restricted and specialized as to be worthless for this job. Many such books are of value merely to throw light upon the narrow point of view and limited experience of the authors. Others only emphasize the author's specialties.

It seems to us that the new book by Strausbaugh and Weimer more nearly represents the proper point of view and more nearly furnishes the material for a good course in introductory biology for colleges and universities than any book we have seen. The book is fairly well balanced. That alone is a real accomplishment. The pedagogy and style are fitted to the undergraduate student. Fundamental phenomena and conceptions are not completely buried in technicalities.

The physics and chemics of biology are extremely simplified, but that is necessary for hosts of students who have never studied physics or chemistry even in high school. The fundamental aspects of the structure, function and life history of organisms constitute major threads for the presentation. The classification of organisms and the major groups of the two kingdoms are given adequate and discriminative space and treatment. The brevity of treatment of such broad topics as variation, evolution, genetics, environmental relations will disappoint specialists in those phases. But the same reaction will follow the examination of the book by special workers in other lines of research. We simply must let ourselves down to the level of the audience which presents itself for instruction in *general* biology. Eight out of every ten of that group have never taken any other course in science. Less than that number will ever take additional courses in the more specialized sciences. The authors of this book seem to have caught the significance of this situation and have tried to select their material and to treat it so as to fit the audience. It is apparently with a keen understanding of the limitations of their audience that the authors assumed this important task. A constant emphasis upon the essential and the usable features of general biology clearly reflects this point of view.

There are several unfortunate blunders and lesser errors in the book. We need not enumerate them here. These may all be corrected in a second printing. We do not favor the inclusion of lists of "selected references," as is generally done after each chapter in the book. Mighty few students even look *at* them, much less look them *up*. In fact little time is available for this extra work. The value of such inclusions is to the teacher only. Few teachers ever use such values. The etymology and definition of many terms and words are given, as a rule, where they are first used. A formal glossary is omitted. Our experience teaches us, however, that numerous students use and benefit from a carefully prepared glossary. The book is well manufactured. The typography is well selected for the student and teacher. Many of the plain figures are new, generally well done and of great value. The colored plates are certainly welcome.

On the whole this book is admirable for a two-semester course. It should go a long way to aid teachers and administrators to solve the difficult problems associated with the presentation of so general a topic in the curriculum of higher education. We are using it with success.

RAYMOND J. POOL
UNIVERSITY OF NEBRASKA

SEDIMENTARY PETROGRAPHY

Manual of Sedimentary Petrography. W. C. KRUMBEIN and F. J. PETTIJOHN. 549 + xiv pp., 265 figs. D. Appleton-Century Company, New York, London, 1938. Price, $6.50.

UNTIL recently, petrographers have neglected the study of the sedimentary rocks, as they were considered uninteresting and it was believed that their study would lead to few results of general interest. However, in the last two decades interest in these rocks has grown rapidly and now sedimentary petrography is an active and well-developed science. It is actively contributing to the precise correlation of strata; to our knowledge of diastrophism, the location and character of old land masses, the source of the materials of the sediments, the former climatic conditions and many other problems.

The excellent book under review shows how far the new science has developed; in some respects its methods are already more quantitative than are those used in the study of the igneous rocks. As stated in the introduction, "The purpose of the book is to present theories and methods of examining sediments, from the field sampling to the final graphic and statistical analysis."

The first part by Krumbein discusses the collection and preparation of samples, the principles, methods and graphic presentation of mechanical analyses, statistical methods as applied to the data of sedimentary rocks and orientation analyses of sediments. The second part by Pettijohn treats of the shape and surface textures of grains; preparation of samples for mineral analyses, such as disaggregation and clarification of grains; separation methods by heavy liquids, the electromagnet and other methods; optical methods; mineral description and determinative tables; mineral frequencies; chemical methods; and the mass properties of sediments, such as color, density and porosity. The final chapter deals with equipment, reference books, etc.

The book is clearly written and well organized; it covers its field admirably and includes the latest developments in a rapidly progressing science. It should become a widely used text and reference book.

ESPER S. LARSEN, JR.
HARVARD UNIVERSITY

SOCIETIES AND MEETINGS

SPECIAL RESEARCH CONFERENCES ON CHEMISTRY

THREE research conferences on chemistry have been organized by Dr. Neil E. Gordon, secretary of the Section on Chemistry, which will be held at Gibson Island, Maryland, between July 10 and July 28, under the auspices of the American Association for the Advancement of Science. These conferences follow a

similar conference held last summer in the same place that proved to be very successful.

In organizing these special research conferences, Dr. Gordon has initiated a kind of meeting that is entirely new and that promises to be effective in promoting the interests of science. For this reason the officers of the association have given this experiment their approval. It is quite possible that there are other kinds of conferences, meetings or field trips that the association might sponsor or in which it might participate to the advantage of science. Like science itself, the association should not be static but always experimenting and alert for new ways of advancing science and our civilization.

The programs of the conferences at Gibson Island are as follows:

RESINOUS POLYMERS

(July 10–14)

L. H. Baekeland, *Honorary Chairman;* Howard L. Bender, *Chairman*

July 10. "Introduction," by L. H. Baekeland, Bakelite Corporation, Bloomfield, N. J.
"The Physical Viewpoint of Resinous Particles as to Size and Linkage," by Howard L. Bender, Bakelite Corporation, Bloomfield, N. J.
Leader of discussion of preceding paper, Tom Midgley, Ethyl Gasoline Corporation, Detroit, Mich.
Dinner at 7:00 P.M. in honor of Dr. Baekeland.

July 11. "The Infusible Resinous State," by R. H. Kienle, The Calco Chemical Company, Inc., Bound Brook, N. J.
"Conditions for Infusibility," by S. S. Kistler, Norton Company, Worcester, Mass.

July 12. "The Resinous Vinyl Compounds," by S. D. Douglas, Carbide and Carbon Chemicals Corporation
"Polystyrene," by Ivy Allen, Bakelite Corporation, Bloomfield, N. J.

July 13. "The Structure of Some Vinyl Polymers," by C. S. Marvel, University of Illinois, Urbana, Ill.
"Spectroscopy and Resin Structure," by R. B. Barnes, American Cyanamid Company, Stamford, Conn.

July 14. "Electronic Structure and the Behavior of Cellulose Compounds," by G. M. Kline, National Bureau of Standards, Washington, D. C.
"Viscosity and Constitution of High Molecular Weight Substances," by P. J. Flory, University of Cincinnati, Cincinnati, Ohio

VITAMINS

(July 17–21)

C. G. King, *Chairman*

July 17. "Problems and Policies in Relation to the Vitamins in the Enforcement of the Federal Food, Drug, and Cosmetic Act," by E. M. Nelson, U. S. Department of Agriculture, Washington, D. C.

July 18. "The Biochemical Reactions of Vitamin C," by C. G. King, University of Pittsburgh, Pittsburgh, Pa.
"Vitamin B_1 (Thiamin) Analysis, Assays and Specific Functions," by R. R. Williams, Bell Telephone Laboratories, New York, N. Y.

July 19. "The Identity and Function of the Newer Members of the Vitamin B Group," by C. A. Elvehjem, University of Wisconsin, Madison, Wisconsin
"The Hydrogen Carrier Function of the Vitamins, Limited to Riboflavin and the Nicotinic Acid Amide Containing Coenzymes," by C. V. Smythe, University of Pennsylvania, Philadelphia, Pa.

July 20. "Vitamin A," by K. Hickman and E. Le B. Gray, Eastman Kodak Company, Rochester, New York
"Physiological Functions of the Vitamin A," by George Wald, Harvard University, Cambridge, Mass.

July 21. "Vitamin D," by C. E. Bills, Mead Johnson and Company

RELATION OF STRUCTURE TO PHYSIOLOGICAL ACTION

(July 24–28)

Walter H. Hartung, *Chairman*

July 24. "Local Anaesthetics," by Arthur J. Hill, Yale University, New Haven, Conn.

July 25. "Sulfanilamide Derivatives," by The Calco Chemical Company, Inc., Bound Brook, N. J.

July 26. "Relationships Between Physiological Action and Constitution in a Series of Morphine Derivatives and Synthetic Analgesics," by Lyndon F. Small and Erich Mosettig, University of Virginia, University, Va.

July 27. "Certain Significant Physico-Chemical Factors in Cell-Drug Reaction," by M. E. Krahl and G. H. A. Clowes, The Lilly Research Laboratories, Indianapolis, Ind.
"Hypnotics," by W. G. Bywater, Parke, Davis and Company, Detroit, Mich.

July 28. "The Carcinogenic Activity, Structure and Chemical Properties of Polynuclear Aromatic Hydrocarbons," by L. F. Fieser, Harvard University, Cambridge, Mass.

The meetings begin at 10 o'clock, with one or two formal papers outlining the fields of research and directing attention to the unsolved problems. Since not more than two papers are given on any one day, it is possible to have the discussion of the papers not limited in any way. The program will also permit time for certain recreational features which the island affords.

Since the accommodations on the island are limited, it is advisable to make reservations in advance. For reservations or further information, application should be made to the secretary, Neil E. Gordon, Central College, Fayette, Mo.

F. R. MOULTON

REPORTS

GRANTS FOR RESEARCH OF THE GEOLOGICAL SOCIETY OF AMERICA

TWENTY-EIGHT grants in support of special research projects were authorized by the council of the Geological Society of America at the April meeting, as follows:

Ralph E. Grim, Illinois State Geological Survey, Urbana. Dr. Grim's well-known exhaustive studies of clays of Illinois have developed a strong interest in the genesis and evolution of the several minerals of the clay groups. In the main, however, materials available to him until now were from the Pennsylvania underclays. With this grant from the society he will have the opportunity to apply his researches to large collections of recent marine clays taken from the floor of the Pacific, $1,800.

Charles A. Anderson, University of California, Berkeley, and Charles W. Merriam, Cornell University, Ithaca, N. Y. Dr. Anderson and Dr. Merriam will spend five to six weeks during the coming summer in the Roberts Mountains, one of the Basin Ranges of western Nevada, rechecking the distribution of Tertiary volcanics and their relationship to the later faulting. An important key to the later structural history of the central Great Basin may be disclosed. Stock-like bodies and sills of alaskite porphyry cutting the Paleozoic formations in the southern portion of the range present a number of interesting problems of petrogenesis to be worked out. $600.

Louis L. Ray, Harvard University, and J. Fred Smith, Jr., Texas Agricultural and Mechanical College. Dr. Ray and Dr. Smith plan to spend ten weeks in the Moreno Valley in the Sangre de Cristo Mountains of northern New Mexico on a study of the tectonic history of the vicinity. This is considered a critical area for the study of the orogenic history of the southern Rocky Mountains. $650.

S. A. Berthiaume, Cornell University, Ithaca, N. Y. Dr. Berthiaume will go to Diamond and White Pine mountains of east-central Nevada to make a detailed study of the late Paleozoic stratigraphy of, and establish a typical section for, that part of the Great Basin. His work will contribute to our knowledge of the late Paleozoic physical conditions, the structure and volcanic history of the Great Basin, and, it is hoped, may disclose an identifiable flora in the white pine shade in which fragmentary plant remains are known. $250.

Ralph W. Chaney, University of California, Berkeley. Dr. Chaney will assemble all the available data on the character and occurrence of late Tertiary vegetation in western America. This is expected to fill out a little-known chapter of floral history. It will have a critical bearing on the interpretation of later Tertiary vertebrates and invertebrates and will assist in the correlation of several of the terrestrial formations of the region. $600.

N. H. Darton, U. S. Geological Survey, Washington. Dr. Darton will continue his field studies of the overlap relations of the Tertiary and Cretaceous formations in eastern Maryland and Virginia. During the course of the study to date several very significant stratigraphic features in the Eocene succession which throw considerable light on the structure and overlap relations have been made manifest. $450.

Victor T. Allen, St. Louis University. Professor Allen will devote several weeks to field work on the west side of the Great Valley of California collecting samples of Eocene white clays and sands. The samples will be studied petrographically, chemically and by x-ray technique, and comparisons will be made with results already in hand from the Ione formation on the east side of the valley. The research is an attempt to answer the question as to whether during the Eocene Sierran minerals were carried across what is now the Great Valley or whether anauxite clays formed at nearly the same time on two widely separated terranes. The results will be a contribution to the physiographic and climatic conditions during the Eocene. $500.

Robert P. Sharp, University of Illinois, Urbana. Dr. Sharp will go to the Ruby-East Humboldt Range of Nevada for two months of field work in completing his study of the boundary structures and Cenozoic history of this Basin Range. The study is expected to contribute to the relations between pre-Tertiary and Basin Range structures. Furthermore, in the southern part of the range the formations are unmetamorphosed, and it will be possible to establish the stratigraphy and thereby contribute to studies in the northern part, where igneous intrusions have cut the formation to pieces. $310.

F. J. Pettijohn, University of Chicago. Professor Pettijohn will continue his study of the lithology and stratigraphy of the early pre-Cambrian sediments in the Thunder Lake region of Ontario. He expects to spend three or four weeks in the field on a special study of the occurrence of calcareous concretions and limy beds and to make special collections for petrographic and chemical analyses. The record of concretions in the early pre-Cambrian is scanty, and Professor Pettijohn plans to contribute data on these to support the doctrine of uniform operation of geological processes throughout geologic time. $175.

Curtis J. Hesse, Texas Agricultural and Mechanical College. Dr. Hesse is to study a collection of fossil vertebrates from the Gulf Coast of Texas. His report on this collection will provide a means of correlating the marine Miocene invertebrates of the Gulf Coast with the fresh-water Tertiary of the mid-continent and allied faunas of Florida. $500.

Henry C. Stetson, Harvard University. Dr. Stetson's work with the Woods Hole Oceanographic Institution during the past two years has included the taking of about fifty cores from the continental slope and in the Atlantic basin by means of the "Piggot gun." The study of the cores is contributing to our knowledge of

the Pleistocene history of the Atlantic basin and of the conditions of deposition on the slope and in the canyons. The grant is to furnish spare parts for the "gun" in order that operations need not be interrupted by inevitable losses. $215.

John W. Wells, Ohio State University. Dr. Wells and Dr. T. Wayland Vaughan are completing a revision of the madreporarian hexacorals. Since 1884, when the last compilation was made, a considerable volume of data has accumulated concerning the morphology, classification, ecology and geologic distribution of this group, which has played an important role in the formation of coral reefs since Triassic time. The monograph will represent an intensive investigation of original type material both in this country and in Europe and will present a unified outline of present knowledge, paleontologic and zoologic, of this group. $200.

Richard Foster Flint, Yale University. Professor Flint will spend five weeks in an investigation of the emerged Pleistocene marine features of southwestern Newfoundland. The study will lead to a better understanding of the crustal deformation related to glacial unloading in northeastern North America. The research will contribute to the project to be undertaken by Professors Twenhofel and MacClintock on the physiography and glaciology of the interior and will tie in directly with that on strandline study to be undertaken in Labrador by Professor V. Tanner. $845.

Kenneth E. Caster, University of Cincinnati. Dr. Caster's grant is to enable him to complete his catalogue of the North American Devonian Pelecypoda types. $500.

Paul F. Kerr, Columbia University. Professor Kerr plans to spend about six weeks in the tungsten-bearing area of southern Idaho, Nevada, northwestern Arizona and southeastern California, visiting localities previously studied during the course of the past six years as well as others not yet examined. Following necessary laboratory studies a comprehensive report on the tungsten mineralization in the Basin Range region will be prepared. $1,510.

Edward C. H. Lammers, Washington and Lee University, Lexington, Va. Professor Lammers will spend two and a half months in the southern part of the Beartooth Range continuing his structural studies of the past three field seasons. He wishes to determine the amount of coincidence between Laramide and pre-Cambrian structures in order to evaluate the importance of pre-Cambrian zones of weakness in controlling the Laramide deformation of this typical Rocky Mountain uplift. $565.

Maurice Ewing, Lehigh University, Bethlehem, Pa. Professor Ewing will continue his geophysical studies of the emerged and submerged Atlantic coastal plain. The researches of the past three years consist of the measurement of the depth of bedrock across the coastal plain, the shelf and into the oceanic basin. It is hoped that they will clarify the fundamental differences between continents and ocean basins, answer the question of the continuation of continental geologic structures into ocean basins, and give data on the permanence of ocean basins. The work planned under this grant will cover measurements in shallow water at Long Island, Barnegat Bay, Cape May and off the eastern shore of Maryland. $1,200.

Charles Deiss, Montana State University, Missoula. Professor Deiss will spend six weeks in southern Alberta and British Columbia in continuation of his revision of the Cambrian in the northwestern states and in the southern part of the Canadian Rockies. This work carried on since 1931 has contributed to the establishment of a usable standard Cambrian time scale for North America and to the paleogeography and sedimentation in the Cordilleran region during Cambrian time. $540.

Fred. B. Phleger, Jr., Amherst College, Amherst, Mass. Dr. Phleger is to continue his study of the Foraminifera in cores obtained by means of the "Piggot gun" in the basin of the North Atlantic Ocean. His researches are contributing to our knowledge of the distribution of cold- and warm-water areas during the Pleistocene and Recent epochs, of the depth and areal distribution of living Foraminifera, and of the rate of sedimentation in the ocean basin. $600.

Girard Wheeler, Rutgers University, New Brunswick, N. J. Dr. Wheeler is planning to spend several weeks at Jeptha Knob in Kentucky, extending his study of the structure and stratigraphy. Trenching at strategic points near the base is expected to disclose whether certain dipping strata are due to landsliding or to late Ordovician deformation. Other trenches near the top are expected to disclose whether the surface below the Silurian capping is an angular unconformity. Fossils will be collected for later determination and check on the stratigraphy. $150.

Max Demorest, University of North Dakota, Grand Forks. Professor Demorest will devote two months visiting active glaciers in the northern Rockies, the Cascades and the Canadian Rockies. He will study the structure and flow of glacier ice by means of a modification of the technique of petrofabric analysis. Oriented specimens will be cut and observed in the field. Other specimens of glacier ice will be shipped for laboratory testing. $600.

Marland P. Billings, Harvard University. Professor Billings will devote the summer of 1939 to field work in the Presidential Range, New Hampshire, continuing a special investigation of the changes in chemical composition that have affected high-grade metamorphic rocks. At present there is the suggestion that certain stratigraphic units have undergone slight chemical change, while others have been very susceptible. $500.

Willard H. Parsons, Hamilton College, Clinton, N. Y. Dr. Parsons will go to the Deer Creek-McLeod area in southern Montana to complete a study of the eruptive and intrusive rocks of the Stillwater-Boulder River area. He expects, among other things, to discover the loci of origin in the Deer Creek volcanics and to determine whether or not the Deer Creek igneous rocks were produced during a minor orogenic episode foreshadowing the main Beartooth thrusting. His work will be a contribution to the relation of volcanic activity to the Beartooth thrusting. $400.

J. Harlan Johnson, Colorado School of Mines, Golden. Professor Johnson is to examine Permian algal limestones of Colorado and New Mexico to obtain data on the origin and conditions of deposition as well as descriptions of the lime-secreting algae. $225.

George W. Bain, Amherst College, Amherst, Mass.

Professor Bain will spend six weeks at Marble, Colorado, investigating the fabric of the Treasury Mountain granite and its roof rocks. This study is expected to demonstrate the effect of recrystallization upon petrofabric of quartz, calcite and mica in a variety of rocks, the relation of fabric and grain stability to distance from the intrusive, the areal distribution of strain around a plutonic intrusive and the relationship between contact metasomatism and strains. Data on strains in the granite and the adjacent roof may be expected to yield data bearing upon viscosity of magmas. $300.

Charles C. Mook, American Museum of Natural History, New York, N. Y. Dr. Mook will continue the work on his monograph on the Fossil Crocodilia of the World. This work has been under way for a number of years and will be brought to completion during the year. $1,500.

David Griggs, Jefferson Physical Laboratory, Harvard University. Dr. Griggs's investigation of the deformation of rocks by low stresses acting over long periods of time has been going on for two years. The laws of dry deformation have already been outlined. New experiments on specimens deformed while immersed in solutions show marked differences in behavior. New "creep testers" provided for under this grant will permit further investigation of recrystallization flow. $1,200.

Horace G. Richards, New Jersey State Museum, Trenton. Dr. Richards will join forces with Professor H. H. Hess, of Princeton University, on an expedition to the Island of Margarita off the eastern Venezuelan coast, there to collect and study Pleistocene and Recent mollusks. His work will be of immediate value to Professor Hess in his studies of the very large negative gravity anomalies of the vicinity and will contribute further knowledge of the paleogeography of the Caribbean region. $300.

SPECIAL ARTICLES

ON THE PRESENCE OF AZOTOBACTER AGILIS IN AMERICA

BEIJERINCK[1] created the genus *Azotobacter* for the non-symbiotic nitrogen-fixing aerobic bacteria discovered by him in 1901. Two species were suggested; namely, *Azotobacter chroococcum,* a soil organism, and *Azotobacter agilis,* isolated from water. Lipman,[2,3] in America, described two additional species: *Azotobacter Vinelandii* and *Azotobacter Beijerinckii.* The former is related to *Az. agilis* by the formation of a greenish pigment, while the latter is similar in certain characters to *Az. chroococcum.* All four species are recognized at the present time. In addition, other species reported in the literature are *Azotobacter Woodstownii* by Lipman[3] and *Azotobacter vitreum* by Löhnis and Westermann.[4] These, however, generally are not recognized as well-defined species.

Of all the above *Az. chroococcum* is considered the most typical species of the group, and apparently it has world-wide distribution in soil. *Az. Vinelandii* and *Az. Beijerinckii* have been reported also as present in soil, although not so frequently as the former species. It was first believed that the presence of *Az. agilis* was restricted to the canal water of Delft, Holland, from which the original isolation was made by Beijerinck. The Beijerinck strain being lost, Kluyver and van Reenen[5] isolated an organism identical with *Az. agilis* excepting that there was a lack of pigment formation. Later, Kluyver and van den Bout[6] isolated a pigment-forming strain, and considering it typical of *Az. agilis,* they named the previous isolation *Azotobacter agilis* var. *atypica.*

Recently, the extensive investigation of Winogradsky[7] reported the isolation of this species from surface waters in France. Many characteristics useful in the identification of the species were included in this publication. This isolation, together with the present report, indicates that *Az. agilis* may be distributed more widely than was supposed previously.

In the present investigation, begun in early July of 1938, the technique of Winogradsky was followed using several samples of surface water in 100 cc amounts of different origins at Madison, Wisconsin, and, later, from San Francisco, California. In addition to the original medium recommended by Winogradsky, in which ethyl alcohol is the source of carbon, a slight modification of this was included in which Fe citrate was substituted for Fe chloride.

As shown in Table 1 five samples of water and one sample of sewage effluent were positive out of twenty-two samples examined. The advantage of the modified medium is shown in samples 1, 3 and 5, in which growth occurred only in the modified medium and also in samples 2 and 4, in which cases growth occurred first in the modified medium. Positive samples were characterized by a peculiar purple or violet coloration, especially in the modified medium.

The strains isolated although similar, may be divided into two groups. The strains isolated from lake water are characterized by the lack of pigment and scanty growth in solid mediums, and the production of a

[1] M. W. Beijerinck, *Centralbl. f. Bakt.,* II Abt., 7: 561–582, 1901.
[2] J. G. Lipman, N. J. Agr. Exp. Sta. Ann. Report, 24: 217–285, 1903.
[3] *Ibid.,* 25: 237–289, 1904.
[4] F. Löhnis and T. Westermann, *Centralbl. f. Bakt.,* II Abt., 22: 234–254, 1909.
[5] A. J. Kluyver and W. J. van Reenen, *Archiv f. Mikrobiol.,* 4: 280–300, 1933.
[6] A. J. Kluyver and B. T. van den Bout, *Archiv f. Mikrobiol.,* 7: 261, 1936.
[7] S. Winogradsky, *Ann. Inst. Pasteur,* 60: 351–400, 1938.

TABLE 1
COMPARATIVE ENRICHMENTS FOR *Azotobacter agilis* WITH WINOGRADSKY'S AND MODIFIED MEDIUMS

No.	Sources of the water	Original W. medium	Modified medium	Observations
1	Lake Mendota (Madison, Wisconsin) sample No. 1	–	+	.....
2	Lake Mendota (Madison, Wisconsin) sample No. 2	+	+	First growth in modif. medium
3	Lake Mendota (Madison, Wisconsin) sample No. 3	–	+	.....
4	Sewage effluent (Madison, Wisconsin)	+	+	First growth in modif. medium
5	Lower Crystal Spring Reservoir (San Francisco, Cal.)	–	+	.....
6	San Andres Reservoir (San Francisco, Cal.)	+	+	.....

Total number of samples examined for the presence of *Az. agilis:* 22.

faint gold or purple pigment in liquid mediums depending on the nature of the carbon source. In contrast to these, the strains isolated from sewage produced a definitely greenish pigment and grew better in agar mediums. Pigment production in liquid mediums was stronger than in the other group of cultures. The strains of both groups are very motile, and in general the morphological and physiological characters agree with those of the descriptions by the previous investigators. The size of the cells is 2.4–2.8 × 2.5–4.5 μ (taken from pictures originally magnified 200 ×). The cultures used for measurement were grown on Winogradsky's medium with 1 per cent. agar and 0.5 per cent. ethyl alcohol, and a small amount of calcium carbonate. No cultures grew with the use of mannite as a source of carbon, either in liquid or in solid mediums.

For comparison a culture of *Az. Vinelandii* from the Department of Agricultural Bacteriology of the University of Wisconsin was included in this study. Morphologically it differs from *Az. agilis* strains by having elongated cells (1.4–1.6 × 2.5–3.5 μ), usually in pairs, and it is less actively motile. In contrast to the *Az. agilis* the strain of *Az. Vinelandii* grew readily on both solid and liquid mediums with mannite as a source of carbon, producing a greenish fluorescent pigment.

The author wishes to express his gratitude to the Guggenheim Foundation, which granted the study; to Dr. E. B. Fred, dean of the Graduate School, University of Wisconsin, for the facilities in the Department of Agricultural Bacteriology; to Dr. Elizabeth McCoy and L. Gee, of this department, for several samples of water included in the study; to Dr. K. F. Meyer, director of the Hooper Foundation, University of California, also for laboratory facilities; to Dr. C. B. van Niel, the Hopkins Marine Station, Stanford University, to whom the findings were submitted for criticism, and to Dr. L. S. McClung, the Hooper Foundation, for aid received in the preparation of the present report.

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LIVER EXTRACT AS A SUBSTITUTE FOR SERUM IN THE CULTURE MEDIUM FOR ENDAMOEBA HISTOLYTICA[1]

THE first practical method for the cultivation of *Endamoeba histolytica* was published by Boeck and Drbohlav[2] in 1925. The medium consisted of a solid egg slant overlaid with a liquid composed of eight parts sterile Locke's solution and one part of sterile human blood serum. The following year Dobell and Laidlaw[3] used horse serum instead of human serum in the liquid portion of the medium and demonstrated that the addition of sterile rice starch produced more abundant growth of the amoebae and prolonged the life of the cultures, thus requiring less frequent transplants. This medium is used extensively at the present time in the cultivation of *E. histolytica.* Although many suggestions for the improvement of this medium have been made, they have consisted of changes only in the solid portion of the medium. The liquid portion of the medium has consisted in all cases of dilutions of human or animal serum or egg albumen, the most widely used being horse serum-Ringer (1–6). Numerous substitutes have been tested, notably by Cleveland and Collier,[4] but without success.

During the past six months we have been using a 0.5 per cent. solution of liver extract in an 0.85 per cent. solution of sodium chloride as a substitute for horse serum-Ringer. The results obtained have been fully as good as with the serum medium, and the advantages of liver extract in both experimental and diagnostic work are many.

The liver extract which we have used most extensively is Lilly's liver extract No. 343, which is employed in the treatment of pernicious anemia.[5] The powdered commercial product is dissolved in normal saline and sterilized in an autoclave at 15 pounds pressure for 30 minutes. The solution need not be filtered, as there is very little sediment. The solution of liver extract is then added to the sterile solid medium together with a small amount of sterile rice flour. The medium is then tested for sterility by incubating for 24 hours, and is stored in the refrigerator until used.

[1] Assisted by a grant from the Division of Medical Sciences of The Rockefeller Foundation.

[2] W. C. Boeck and J. Drbohlav, *Amer. Jour. Hyg.*, 5: 371–407, 1925.

[3] C. Dobell and P. P. Laidlaw, *Parasitology*, 18: 283–318, 1926.

[4] L. R. Cleveland and J. Collier, *Amer. Jour. Hyg.*, 12: 606–613, 1930.

[5] Kindly furnished for experimental purposes by Eli Lilly and Company.

We have experimented with several other materials beside whole egg-Ringer for the solid portion of the medium, such as Cleveland and Collier's liver infusion agar, plain agar, plain agar made up in 0.5 per cent. liver extract and Loeffler's blood serum. The best results have been obtained with whole egg and with Loeffler's serum. The other materials have not produced good growth. It is interesting that Cleveland and Collier's liver infusion agar, which produces excellent growth when overlaid with horse serum-Ringer, gave very poor growth when overlaid with liver extract.

Various dilutions of the liver extract have been used, ranging from 0.2 to 2.0 per cent. The best results have been obtained with the 0.5 per cent. solution. We have also found that the addition of horse serum to the liver extract solution in varying dilutions does not produce any better growth than the liver extract solution alone.

In addition to Lilly's liver extract No. 343 we have tested the following preparations and have found them equally serviceable in 0.5 per cent. dilution: Lederle's "Solution Liver Extract Parenteral," Lederle's "Liver and Iron" in powder form, Wilson's "Liver Extract" solution with 0.5 per cent. phenol and Valentine's "Solution Liver Extract."

Approximately six months ago four strains of *E. histolytica*, which were being maintained in the egg-horse serum-Ringer medium, were transferred to the egg-liver extract-saline medium. These four strains had been under cultivation in our laboratory for a period of from two to six years. The cultural characteristics of these four strains have remained the same in the liver medium as in the horse serum medium. Cyst production is equally good in the two media, in both tube and flask cultures. At the present time we are using the liver extract medium in all our experimental work.

The use of 0.5 per cent. liver extract in the cultivation of *E. histolytica* directly from stool specimens also has certain advantages. We have never failed to initiate growth from a fresh stool in which cysts or motile forms of *E. histolytica* have been found by microscopic examination, and the growth has been uniformly more abundant after 24 hours than in the horse serum medium. *Blastocystis hominis*, which often interferes with cultures in the horse serum-Ringer medium, does not multiply in the liver extract medium.

We have not studied extensively the use of liver extract in the cultivation of the other intestinal amoebae of man. Attempts to cultivate *E. coli* and *Endolimax nana* have failed. Several cultures of both *Trichomonas hominis* and *Chilomastix mesnili* have been obtained from stools and have been maintained until discarded. A few attempts to cultivate *Giardia lamblia* from cysts have failed.

Other advantages of the liver extract over horse or human serum are that it can be resterilized several times without injury, it is inexpensive, it is available as a commercial preparation, it is easily prepared for use, and it requires much less aseptic manipulation than horse or human serum.

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ADRENAL ATROPHY AND SENESCENCE PRODUCED BY A VITAMIN DEFICIENCY

IN the course of experiments with young rats on the symptoms produced by deficiency of the factors in the vitamin B_2 complex[1] it was noted that the fur of black and brown rats gradually turned gray, coarse and lifeless when they were deprived of the filtrate factor or factors. The growth of these animals was usually subnormal and the graying developed only after eight to sixteen weeks of depletion, when the animals were twelve to twenty weeks old.

If the mothers were deprived of the factor from the day of the birth of the young the young rats developed the graying as early as eight weeks of age. If the mothers were deprived of the factor from the day of mating the litters were of normal size and weight, but none could be reared to weaning age. Filtrate factor deficiency is decidedly more damaging to milk production than is deficiency in either vitamin B_6 or riboflavin.

When the gray rats are kept in the deficient state for several months there occurs a peculiar sloughing of spots and patches of the skin, sometimes an inch or more in diameter with lazy ulcers resulting, which remain unchanged for months. Crystalline vitamin B_6 in large doses has no curative effect on these ulcers, but administration of concentrates of the filtrate factor brings about rapid healing. These ulcers are reminiscent of the "leg ulcers" of nutritional origin reported from the tropics.

The graying and all accompanying changes can be cured in a few weeks by administration of filtrate factor concentrates or, the graying at least, by injection of relatively large doses of adrenal cortex extract. The symptoms are not relieved by additional B_1, B_6, riboflavin, copper or iron, or by nicotinic acid or epinephrin. The effect of thyroxin is still in doubt.

Histological study of the skin, hair, adrenals and gonads of these animals have revealed striking and consistent atrophy of the adrenals, loss of elastic layer of the skin, failure of spermatogenesis, atrophy of hair follicles. Intermediate stages in this degenera-

[1] Morgan, Cook and Davison, *Jour. Nutr.*, 15: 27, 1938.

tion have been detected paralleling the graying and regenerative stages studied during recovery.

We have also been able to turn the fur of one black guinea pig completely gray by a diet deficient in this factor and have produced graying of hair about the mouths of two young Boston bull pups.

Apparently many of the physical changes of senescence have been produced in these animals in the course of a few weeks by depriving them of the unknown dietary factor which affects particularly the function of the adrenal cortex.

The curative concentrates have been made from yeast, rice bran and liver. Whether the filtrate factor in question is the same as the anti-chick pellagra filtrate factor of Lepkovsky, Jukes and Krause[2] is not at present known.

A full report of these experiments will appear elsewhere.[3]

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BACTERIAL LEAF-SPOT DISEASES[1]

AN investigation has been made of the leaf-spot of Pennsylvania cigar-leaf tobacco, commonly known as "wildfire." Evidence obtained in these laboratories indicates that the organism associated with the leaf-spot, *Phytomonas tabaca,* is a transitory physiological adaptation of the common saprophyte, *Pseudomonas fluorescens.* This organism, in various physiological adaptations, is found in large numbers on normal tobacco. It is apparent from the data obtained in these investigations that all Pennsylvania cigar-leaf tobacco is exposed to this organism throughout the growing and ripening period and that infection in the field is due not to the mere presence of the organism, which is ubiquitous, but to improper host nutrition.

Single cell isolations of various adaptations of the organism have been the subject of physiological and serological studies. The particular adaptation, or what might be termed by the plant pathologist "relative virulence" has been found to vary greatly according to the source of the isolation. Distinct physiological characteristics have been found to be typical of these various isolates. Rapid changes may be made in the laboratory at will, both in the direction of increased and decreased virulence. Serologically, it appears that the "virulence" of the organism is associated with the specific nature and amount of the capsular material of the cell. Although the particular adaptation of the organism is probably related to severity and rapid spread of infection in those cases in which the tobacco plant is suffering from improper nutrition, the evidence indicates on the other hand that the most "virulent" adaptations of the organism are unable to cause economic loss in those cases in which the nutrition of the plant is satisfactory, other things being equal.

The normal tobacco plant of the cigar-filler type is very resistant to infection of economic severity during the growing season. Leaves of such a plant ordinarily contain at maturity between 3 and 4 per cent. nitrogen and between 4 and 5 per cent. potassium. Changing agricultural practices of the past quarter century have resulted in the general production of an abnormal tobacco from the standpoint of nitrogen and potassium content.

Investigations have shown that, contrary to the opinions expressed in publications by other workers, it is not the exact nitrogen level within reasonable limits that is important but the ratio of nitrogen to certain minerals within the plant and, of extreme importance, the stage in which high nitrogen uptake occurs.

Any condition which leads to the accumulation in the plant of a greater quantity of nitrogen than potassium results in poor quality and susceptibility to leaf spot troubles. It is not to be inferred from this that potassium is the only other element which must be available to the plant in order to insure quality and disease resistance. Potassium is, however, the element needed in greatest amount and apparently most frequently deficient in the Pennsylvania area.

It is not during the period of active growth but during the period of ripening that faulty agricultural practices may lead to the greatest susceptibility to leaf-spot. Our investigations have shown that, regardless of the nutrition of the plant prior to this period, the uptake of significant quantities of nitrogen during the ripening period results in an appreciable lowering of the normal resistance of the plant to wildfire. In Pennsylvania certain practices are necessary which accentuate the abnormal condition brought about by significant nitrogen uptake during ripening and greatly increase the susceptibility of those plants taking up large quantities of nitrogen during the ripening period. These include "topping" and "suckering" which take from the plant the possibility of utilizing large amounts of nitrogen at this period in the proliferation of new tissue. It is significant that wildfire was not a problem in Pennsylvania a number of years ago when agricultural practice precluded the possibility of any appreciable ammonification and nitrification at the ripening period.

Practices in Pennsylvania which have been found

[2] Lepkovsky, Jukes and Krause, *Jour. Biol. Chem.,* 115: 557, 1936.

[3] We acknowledge with gratitude help in the interpretation of the tissue changes from Dr. Jesse Carr, of the Department of Pathology, University of California School of Medicine.

[1] Authorized for publication on March 27, 1939, as paper No. 898 in the journal series of the Pennsylvania Agricultural Experiment Station.

be largely responsible for the severity of leaf-spot fections are, in the order of their importance: (1) e incorporation of large quantities of organic nitro- n in the tobacco soils, a portion of which in some asons may remain to be ammonified during the pening period; (2) the use of too much nitrogen d insufficient potash in the fertilization treatment; 3) the use of excessive amounts of lime, which inter- res with the normal potassium uptake of the plant; d (4) in some cases poor tilth, which also interferes ith mineral uptake.

Practices tending to produce a normal resistant plant high quality and good yield are as follows: (1) the e of another crop such as corn between clover and bacco in the rotation to reduce the amount of organic trogen in the soil; (2) preliminary rotting of all anure used on tobacco in order to avoid the risk of ding large quantities of available energy to the soil; 3) the use of liberal applications of well-rotted anure to improve tilth and aid potassium uptake; 4) the use of suitable applications of a well-balanced fertilizer in which the amount of organic nitrogen is less than the amount of inorganic nitrogen; and (5) suitable cultivation to insure maximum uptake of potassium and other essential nutrient materials.

In the course of these investigations it was considered advisable to study physiologically and serologically several other members of the genus *Phytomonas*, associated with leaf-spots. The data obtained indicate that other members of this genus studied are merely temporary physiological adaptations of *Pseudomonas fluorescens*. A brief study of predisposing factors in these diseases further emphasizes the similarity of bacterial leaf-spot diseases and the relation of the pathological condition to the improper nitrogen-mineral nutrition of the host. The results of these investigations will be published in detail in a Bulletin of the Pennsylvania Agricultural Experiment Station.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A SYSTEM OF INDEXING 2×2 INCH SLIDES

The handling of microfilm (35 mm) used in research nd teaching can be divided into three major phases: 1) the filing of negatives; (2) the filing and index- g of positive or negative film-strip reprints of li- rary material; (3) the filing and indexing of 2×2 nch monochrome or natural color slides for use in eaching or in research where color must be recorded.

Considerable interest has been shown in the use of lm-strip,[1, 2] particularly with reference to its biblio- raphic service. However, its value for teaching is istinctly limited by the inflexible sequence of the mages on the film and the technical difficulties in using for projection in natural colors.

The use of film-slides (2″×2″) has received less onsideration in scientific journals, perhaps due to the act that such slides do not serve a new purpose, but erely constitute a means of doing an old job better. ilm mounted between cover glasses is little subject o injury, and the slides can be rearranged for various purposes by different individuals. They have therefore reater usefulness for longer periods of time than film- trip. As compared with larger sizes of lantern slides, he lower cost, the greater ease of carrying many lides and reduced breakage of the microfilm slides akes them a very valuable aid to teaching and re- earch. Since the results of research can never be tilized to the maximum extent unless they are ade- quately exposed through effective teaching, it is appar- ent that the use of microfilm slides, particularly those in color, is well worth the consideration of those engaged in either teaching or research.

The cost of film-slides and their greater versatility of arrangement and use ordinarily requires that large departmental or institutional slide collections be used by several individuals. This necessitates a system of filing and indexing which will enable each user to find slides conveniently, not only in his own major field, but in those of his colleagues as well. Usually information concerning the subject illustrated on the slide and its source is required whenever a slide is used.

Several individuals have cooperated in devising a system for filing and indexing slides that effectively meets these requirements and has proven efficient and very useful in this department. The system is divided into three parts: a subject index, a slide file and a negative file. All may be housed in a filing cabinet designed for 3×5 inch cards.

The subject index is the central part of the system and is responsible for its usefulness. A picture of the slide subject (contact print) is attached with dry mounting tissue to the upper left-hand corner of a 3×5 inch card where it may be readily seen in thumbing through the index. The subject is placed in the remaining space at the top of the card. For brevity the major subjects of the index are abbreviated (G—genetics, E—embryology) and followed by a descriptive sub-title. On the rest of the card is recorded the number of the slide represented, the number of the negative from which it was made, bibliographic ref-

[1] Lee R. Dice, Science, 89: 39, 1939.
[2] Atherton Seidell, Science, 89: 32, 1939.

erence or other notation concerning the source of the material and descriptive information. The subject headings of the index are patterned after the bibliographic indices of those using the material. Colored cards are used for indexing colored slides, white cards for those in black and white.

Any one wishing a certain slide or one on a specific subject turns to that subject in the card index and chooses, on the basis of the picture and attached information, the slide he wants. He may then quickly draw the slide of that number from the slide file.

The slide file is a numerical arrangement of the slides in each major subject. The file of this department is divided into twelve such major fields. As in the card index the subjects are indicated by letters, the slides by numbers. To find slide G-253 one opens the "genetics" drawer and removes the slide bearing that number on the "thumb mark" placed on the upper right-hand corner of the slide as it goes into the projector.

The slides are filed on edge with the numbers toward the front of the drawer, in wooden troughs 2 inches wide by 1½ inches deep inside. A white card which projects slightly above the slides is placed at intervals of 25 slides and bears the number of the series at that point. The troughs are made in units of two, which fit into a 3×5 inch card compartment. Four rows of more than 100 slides each can thus be filed in each of the lower drawers of the cabinet holding the subject index. The bottoms of the troughs are raised above the bottom of the drawer sufficiently to raise the slides to the top of the 3×5 inch compartment. To facilitate removal and handling of slides the inside depth of the trough is one-half inch less than the height of a slide.

The negative file is a comparatively inactive file, since it is likely to be used only for duplication of slides or for making prints of the slide subject. Various methods of filing may be utilized.[1] A convenient one has been to cut the film into strips of three negatives each and place them in 3×4⅞ inch kraft paper coin envelopes ("bags") which are numbered serially. These envelopes are durable and can be filed in a drawer of the cabinet containing the subject index and slides. (Use of the short length of film has not appeared inconvenient in the enlarger or contact printer used, and when a certain negative is required, unnecessary handling of other negatives is avoided.)

The clerical labor and the printing of photographs necessary for the subject index is well repaid in a large collection by the later saving in time required for finding desired slides and by the fact that several individuals can use the same collection effectively and without confusion. Moreover, the experience in this department shows that slides thus catalogued are more extensively used because of the ease with which the desired material can be found.

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LANTERN SLIDES FROM TYPEWRITTEN MATERIAL

THE recent note of Carpenter,[1] under the present title, on typing or drawing through white carbon paper onto black paper, to eliminate one step in the photographic process of making white-background slides is useful for certain work, but we have found that another step—that of retyping text material and retracing diagrams through white carbon paper—can be avoided by photographing the material from which slides are to be made onto a contrast grade direct positive film of the type supplied by the Eastman Kodak Company in their "high contrast direct positive film." The result of using this is a positive film (without having to prepare a negative) which can be bound between two standard size slide glasses with a slide mask as usual, effecting a saving in time of preparation.

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[1] SCIENCE, 89: 372, 1939.

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